Development of Aromatic Rice Varieties


ABSTRACT

The University of Arkansas System Division of Agriculture Aromatic Rice Breeding Program at the Rice Research and Extension Center (RREC), Stuttgart, Ark., was implemented to develop aromatic rice varieties for the southern rice-producing regions. Evaluating cultural practices is essential for the selection of the best lines in the breeding program as well as for developing grower recommendations. Information regarding successful cultural practices of aromatic rice varieties is very limited for the southern United States growing regions, and especially for Arkansas. Beginning in 2010, an experiment was established at the RREC to determine the effect of different nitrogen (N) fertilizer rates on the aroma and yield of aromatic rice varieties. In this test, six N rates were applied to seven aromatic rice varieties and one non-aromatic rice variety. Agronomic and yield data were collected. Hulled and milled seed were tested for the analysis of 2-acetyl-1-pyrroline (2a-p) concentration conducted at USDA-ARS Southern Regional Research Center, New Orleans, La. Results of the yield trials showed mixed varietal response to increased N fertilizer. Some varieties increased in yield while others remained unchanged or decreased with increased N fertilization. Total rice percentages from the first two years of the study varied significantly across varieties.

INTRODUCTION

Approximately 12.9 million cwt of milled rice were imported to the United States in the fiscal year 2010/2011 (USA Rice Federation, 2011). The top exporting countries are Thailand, which produces high quality Jasmine rice, and India, which produces highly desired Basmati rice (USA Rice Federation, 2011). United States consumers are purchasing more aromatic or specialty rices and the overseas markets cannot meet
the demand. It has been difficult for U.S. producers to grow the true Jasmine and Basmati varieties due to environmental differences, photoperiod sensitivity, fertilizer sensitivity, and low yields, thus making aromatic rice a valuable commodity. Adapted aromatic rice varieties need to be developed for Arkansas producers which meet the taste requirements for either Jasmine-type or Basmati-type rice. International research on aromatic rice and N fertilizer indicate that genotype differences in N-use efficiency exists. Two international studies found excess N fertilizer had no effect on grain yield in native aromatic rice cultivars. Research needs to be directed to determine what type of Arkansas soils will produce the best aromatic rice and what is the optimum fertility to produce the best milling quality which will meet the consumers’ demands.

**PROCEDURES**

The aromatic rice breeding program collected parental material from the U.S. breeding programs and the USDA World Collection. Crosses were made to incorporate traits for aroma, yield, improved plant type, superior quality, and broad-based disease resistance. The winter nursery in Puerto Rico is being employed to accelerate generation advance of potential varieties for testing in Arkansas during the summer of 2013. In 2012, 151 heterozygous lines from nine F₄ populations were screened through marker-assisted selection for aroma and amylose content.

A three-year Aromatic Rice by Nitrogen Rate study began in 2010 to help determine the fertility requirements of the various aromatic rice varieties for optimum aroma quality and yield. Eight rice lines: Dellrose, Jasmine 85, Jazzman, Jazzman II, JES, Sierra, Wells, and two University of Arkansas experimental lines were treated with six different N rates: 0, 30, 60, 90, 120, and 150 lb/acre. In 2011, one experimental line was removed from the experiment because it was determined by genetic marker analysis to be non-aromatic. The non-aromatic experimental line was replaced with Jazzman II. Typical plant characteristic data was collected including heading date, plant height, and lodging. The weight and moisture content of each plot was recorded. Hulled and milled seed samples from each plot were tested for the analysis of the aroma compound 2-acetyl-1-pyrroline (2a-p) concentration, which was conducted at the USDA-ARS Southern Regional Research Center, New Orleans, La.

**RESULTS AND DISCUSSION**

In 2012, seven cross-pollinations were made to produce aromatic lines for screening. The F₁ plants from these crosses will be grown in the greenhouse during the winter to produce F₂ seed. The F₂ populations will be planted in 2013 at RREC for observation and selection.

Panicles were selected from 43 F₂ populations in 2012. The parents in these crosses were selected for their aromatic or high seed quality or high yield potential. Approximately 1,650 F₃ lines from 41 populations were shipped to the winter nursery in Puerto Rico to advance. The harvested seed from Puerto Rico will be planted at RREC
for further observation and selection in 2013. Marker analysis will be conducted to
detect or determine the characteristics of aroma, cooking quality, and blast resistance.

Results of the marker-assisted selections of 151 lines from nine F₄ populations
screened in 2012 for aroma and amylose content helped to eliminate lines which did
not meet the breeding program requirements. Approximately 33% of the entries were
homozygous aromatic and had desirable cooking quality (Boyett et al., 2013). Ten
percent of the lines were discarded due to non-parental alleles.

Results of the 2010 Aromatic Rice by Nitrogen Rate study showed grain yield
responses to increased N fertilizer differed among varieties. Dellrose, Jazzman, and
Sierra appeared to be the least affected by the additional fertilizer with Sierra having
the lowest overall yield. STG03-085 had the highest yield with 90 lb N/acre and had the
highest overall yield across the varieties. The yields of JES, Jasmine 85, STG06-126,
and Wells increased with increasing levels of applied N.

Total rice percentages for 2010 resulted in significant differences across varieties
and across nitrogen fertilizer treatments. JES had the lowest and Jazzman had the high-
est overall percentage of total rice. The lowest percentage of total rice was found in all
varieties receiving 0 lb N/acre and the highest percentage was at the 150 lb N/acre rate.

Results of the 2011 Aromatic Rice by Nitrogen Rate study showed grain yield
response to N rates varied among the varieties. Dellrose, Jasmine 85, and STG03-085
grain yields decreased with increased N. STG03-085 had the lowest yields across all
varieties. Jazzman and Wells responded with increasing yields to the additional N.
Jazzman II, JES, and Sierra had no significant yield changes across the N rates. The
non-aromatic control, Wells, had the highest yield in the 2011 test, followed by JES.

Total rice percentages for 2011 were significantly different across varieties but
not across N fertilizer treatments. STG03-085 had the lowest and Sierra had the highest
overall percentage of total rice.

Results of the 2012 Aromatic Rice by Nitrogen Rate study showed grain yield
responses of all varieties increased beginning at 60 lb N/acre. There was no significant
difference in the yields of plots receiving 0 and 30 lb N/acre. There was no significant
difference in the yields of plots receiving 60, 90, 120, and 150 lb N/acre. Sierra and
Dellrose appeared to be the least affected by increased N fertilizer applications, with
Sierra having the lowest yield. STG-085 had the highest yield with 90 lb N/acre and
had the highest yield in this year’s experiment although there was no significant dif-
ference in the yield of STG-085 and Jasmine 85. Jazzman yields ranked third in this
year’s experiment. There was no significant difference in the yields of Wells, Jazzman
II, and JES. Milling results were not available at publication deadline.

ACKNOWLEDGMENTS

The authors appreciate the financial support of the rice producers of Arkansas
through monies administered by the Arkansas Rice Research and Promotion Board. We
thank Virginia Boyett, Veronica Booth, and Vetress Thompson for conducting marker
analysis. We thank Donna Frizzell for planting experiment, Chuck Pipkins for planting
and fertilizing experiment. We thank Merle Anders for statistical assistance.
LITERATURE CITED
